

REMARKS

Claims 1 and 45 have been amended herein. Claims 1-14, 17-24, and 45-49 remain in the application. Favorable reconsideration is respectfully requested.

Claims 1 and 45 have been amended to recite that the claimed method occurs "in the absence of added oxygen." This recitation is supported in the specification by Examples 6, 7, 9, 10, and 11. Specifically, see page 25, lines 10-20; page 27, lines 3-5; page 28, lines 10-15; page 30, lines 1-10; and page 31, lines 10-30. In short, in all of the Examples presented in the specification that address the claimed reaction itself, the reaction is carried out using helium, hydrogen, or nitrogen as the carrier gas (or as the pressurizing gas in Example 12, which takes place in the liquid phase). In none of the Examples of the present application is an oxygen-containing gas or pure oxygen introduced into the reaction mixture (either as a fuel or a carrier gas).

See also the description of the reactor shown in Fig. 5, at page 17, lines 26-29 of the specification. The preferred reactor includes a nitrogen supply 10 and a hydrogen supply 12. Of particular note is that the reactor does not include an inlet to introduce air into the reactor, nor does the reactor include a separate oxygen source. This is because the invention as described in the application does not require added oxygen.

The following remarks address the issues presented in the Office Action dated January 20, 2004, in the order of their appearance:

Rejection of Claims 1-14, 17-24, and 45-49 for Obviousness-Type Double-Patenting:

This rejection is believed to have been overcome by the executed Terminal Disclaimer and required fee submitted herewith.

Please note that the required Certificate Under 37 CFR §3.73(b) was submitted with the application papers as filed. Thus, the assignee of the present application, Wisconsin Alumni Research Foundation, is empowered to execute the enclosed Terminal Disclaimer.

Please also note that while this rejection was couched as a provisional rejection, the underlying application, Serial No. 09/998,552, issued as U.S. Patent No. 6,699,457, on March 2, 2004 (that is, after the mailing date of the most recent Office Action). Therefore (in the interest of compact prosecution) the Terminal Disclaimer submitted herewith is couched as an actual instance of obviousness-type double-patenting in light of the now-issued parent application.

In view of the Terminal Disclaimer and previously filed §3.73(b) Certificate, Applicants submit that the rejection of Claims 1-14, 17-24, and 45-49 for obviousness-type double-patenting has been overcome. Withdrawal of the rejection is respectfully requested.

Rejection of Claims 1-14, 17-24, and 45-49 Under 35 USC §102(b) or, in the Alternative, Under §103(a) Over WO 99/48804:

This rejection is believed to have been overcome by appropriate amendment to independent Claims 1 and 45. Specifically, these two claims have been amended to require that the reaction proceed "in the absence of added oxygen."

In contrast, the WO 99/48804 publication explicitly describes a reaction for generating hydrogen that requires a dimethyl ether fuel and added oxygen. As noted at page 2, line 20 of WO 99/48804, the oxygen is introduced by adding air to the reaction. The added molecular oxygen (*i.e.*, O₂) is critical to the success of the reaction described in WO 99/48804 because the overall reaction is a combination of: 1) a partial oxidation reaction; and 2) a steam reformation of dimethyl ether. See the abstract. **Without the added oxygen, the partial oxidation reaction described in WO 99/48804 will not happen.**

In particular, see the discussion at page 1, lines 15-31 of WO 99/48804. Here, the authors compare and contrast the merits of partial oxidation vs. steam reformation to produce hydrogen. As noted by the authors, partial oxidation is fast and exothermic, and thus results in faster reactor start-up times and short response times. Steam reforming is endothermic, efficient, and produces hydrogen from both the fuel

and the steam. The authors go on to state, however, that the "ideal" hydrogen production route is a combination of partial oxidation and steam reforming. See WO 99/48804, page 1, lines 22-25.

A partial oxidation reaction requires oxygen. See, for example, Exhibit A, attached hereto. Exhibit A is a screen shot from the web site of the Chemical Engineers' Resource Page (www.cheresources.com/hydrogenzz.shtml). Exhibit A presents the various reactions that can be used to generate hydrogen, including partial oxidation (see bottom of first page to top of second page of Exhibit A). Exhibit A explicitly indicates that "The amounts of oxygen and water vapor are controlled so that the reaction proceeds without the need for external energy." The reaction itself shows that for every 10 molecules of H₂ produced, the reaction requires 9/2 molecules of O₂. Without the molecular oxygen on the left-hand side of the partial oxidation reaction, the reaction will not take place.

As amended, the present claims require that the reaction take place "in the absence of added oxygen." Applicants submit that this amendment renders the claims both novel and unobvious from the WO 99/48804 reference. The claims are novel because the WO 99/48804 reference requires that oxygen be added to the reaction. The claims are unobvious because to modify the WO 99/48804 reference to exclude added oxygen would destroy the intended functionality of the reaction described in WO 99/48804. It is well-settled law that where a proposed modification to an applied prior art reference destroys the intended utility or functionality of the reaction described in the applied reference, obviousness has not been shown. See, for example, *In re Gordon*, 733 F.2d 900; 221 USPQ 1125 (Fed. Cir. 1984).

For these reasons, Applicants respectfully submit that the rejection of Claims 1-14, 17-24, and 45-49 under 35 USC §102(b) or, in the alternative, under §103(a) over WO 99/48804 has been overcome. Withdrawal of the rejection is respectfully requested.

Rejection of Claims 1-14, 17-20, and 45-49 Under 35 USC §103(a) Over Wieland et al. (U.S. Patent No. 6,413,449) in View of Edlund (U.S. Patent No. 5,861,137):

This rejection is believed to have been overcome, in part, by appropriate amendment to the claims, and is, in part, respectfully traversed.

This rejection is believed to have been overcome in part by amending the claims to recite that the claimed reaction proceeds in the absence of added oxygen. Insofar as the combination of Wieland et al. with Edlund neither teaches nor suggests such a reaction, this rejection is believed to have been overcome in major part.

The rejection is also traversed on two grounds: 1) the combined references do not teach or suggest the presently claimed invention; and 2) the Office is applying an improper "obvious-to-try" standard, rather than the more stringent obviousness standard required by controlling law.

Regarding the teaching of the combined references, the Office candidly acknowledges that the primary reference to Wieland et al. does not disclose a reaction that utilizes a fuel source having at least two carbon atoms, as is positively required by all of the present claims. The Office thus relies upon the Edlund patent to fill the gaps in the Wieland et al. reference. But the Edlund patent does not mention any other alcohol by name, except methanol. Edlund makes only the most cursory statement that an alcohol, "such as methanol," can be used. But that comment is made with respect to Edlund's own method, not Wieland's method.

There is nothing in the record that supports that Office's contention that Edlund's perfunctory statement "such as methanol" indicates that a larger alcohol would function successfully to make hydrogen using Wieland et al.'s method. Moreover, there is evidence in the record suggesting that such a modification would not work. In this regard, Applicants note that the Office must use the prior art for all of its teaching; the Office is not free to choose selectively from among the pros and cons presented by the prior art.

Specifically, Wieland et al. note that the results of their own attempts to reform methanol over an alumina catalyst are surprising because the expected product is

diethyl ether. (See Wieland et al., col. 5, lines 14-17.) Thus, taking Wieland's shock as true, substituting a larger alcohol in Wieland's process (as suggested by the Office) would be expected to result not in hydrogen, but in unknown, non-hydrogen products, such as larger ethers. What is for certain is that Wieland et al. were surprised by their results using methanol. Based on that surprise, it is a stretch to conclude that the combined references provide any likelihood of success if a larger alcohol were used as the fuel.

Applicant also traverses this rejection because the Office is applying the discredited "obvious-to-try" standard in place of the proper, and more strenuous, obvious standard. In particular, Applicant traverses the Office's statement at page 4 of the Office Action that Edlund's three-word phrase "such as methanol" suggests using a large alcohol in Wieland et al.'s method, when (as noted above) Wieland was shocked that his approach worked at all using methanol. In short, Edlund's passing reference to "such as methanol" does not even remotely suggest the nature of any other alcohol beyond methanol, nor does it provide any reasonable likelihood of success in getting Wieland's method to work with an alcohol larger than methanol. It appears that the combination of Wieland et al. and Edlund might make it obvious to try a fuel other than methanol in Wieland's method, but "obvious-to-try" is not a proper standard for "obvious."

In Re O'Farrell, 7 USPQ2d 1673 (Fed. Cir. 1988), outlines when an invention is obvious, and therefore unpatentable, versus when an invention is obvious-to-try, and therefore patentable. The Court noted two scenarios in which a claimed invention is only obvious-to-try. First, an invention is merely obvious-to-try if it is necessary:

to vary all parameters or to try each of numerous possible choices until one possibly arrived at a successful result, **where the prior art gave either no indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful.**" (7 USPQ2d at 1681, emphasis added, citations omitted.)

Second, an invention is only obvious-to-try where the inventors:

explore[d] a new technology or general approach that seemed to be a promising field of experimentation, **where the prior art gave only general guidance as to the particular form of the claimed invention or how to achieve it.**" (*Ibid.*, emphasis added.)

Applicants submit that in the present case, both scenarios are highly relevant.

With respect to the first scenario, the combination of Wieland et al. and Edlund fails entirely to suggest which alcohol beyond methanol is likely to successfully yield hydrogen. Wieland et al. are limited entirely to a discussion of methanol, and Edlund states nothing more than using an alcohol "such as methanol." That leaves an awful lot of alcohols to explore. And that exploration is tremendously difficult because the thermodynamic qualities of the different possible fuels are vastly different.

In this respect, see the discussion in the present specification starting at page 14, line 12, to page 16, line 12. In short, at page 14, it is noted that the temperature where $\Delta G^\circ/RT$ becomes favorable for steam reformation of methanol is 410 K, a temperature well above the 290 K required to generate a 0.1 atm partial pressure of methanol. But, to do the same with a larger alcohol presents problems due to the inherently higher vapor pressures of the larger reactants. See the bottom of page 14 of the present specification. Thus, while methanol can be steam reformed at about 410 K (due to its vapor pressure) a 0.1 atm partial pressure of sorbitol can only be generated at about 700 K. None of these concerns is even mentioned by the combination of Wieland et al. and Edlund.

Again, the combination of Wieland et al. and Edlund does not suggest any other alcohol beyond methanol to be used. Therefore, Wieland et al. and Edlund cannot provide any direction as to which of many possible alcohols likely to be successful. Wieland et al. and Edlund are simply silent on the matter. The only document suggesting that larger alcohols can be used is Applicants' own disclosure. But the Office cannot use Applicants' disclosure in this fashion.

With respect to the second scenario, the combination of Wieland et al. and Edlund **does not** even provide general guidance as to the particular form of the claimed

invention and how to achieve it. In short, the combination of Wieland et al. and Edlund provides guidance for reactions using methanol and nothing further.

Moreover, obviousness requires that the predictability and/or necessity of experimentation to arrive at the claimed invention be evaluated in terms of the invention as a whole, and not as a sum of its parts. See, for instance, *Hybritech Inc v. Monoclonal Antibodies, Inc.*, 231 USPQ 81 (Fed. Cir. 1986). Here, the Court held unobvious a method of using *monoclonal* antibodies of defined specificity in a prior art process which utilized *polyclonal* antibodies. The Court noted that prior art references which discussed the production of monoclonal antibodies may constitute an invitation to try monoclonal antibodies in the prior art immunoassays, but that the prior art did not render the claims obvious because they did not suggest how that end might be accomplished. In short, the Court held that:

Focusing on the obviousness of substitutions and differences instead of on the invention as a whole...[is] a legally improper way to simplify the difficult determination of obviousness. (231 USPQ at 93.)

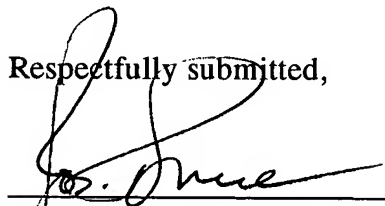
Applicant submits that the *Hybritech* case is directly on point in that the Office is focusing on the obviousness of substitutions and differences (*e.g.*, altering Wieland et al. and Edlund's use of methanol to a larger alcohol to arrive at Applicants' claimed invention), rather than on the invention as a whole. The Wieland et al. and Edlund combination does not render obvious the present invention as a whole because the combination makes only the most cursory statement "such as methanol." That off-the-cuff statement simply is insufficient to render obvious the claimed invention when viewed in its entirety. The combination does not provide a single shred of evidence that Wieland's reaction would produce hydrogen if a feedstock other than methanol were used.

For the above reasons, Applicants submit that the rejection of Claims 1-14, 17-20, and 45-49 under 35 USC §103(a) over Wieland et al. in view of Edlund is untenable. Withdrawal of the same is requested.

CONCLUSION

Applicants submit that the application is now in condition for allowance. Early notification of such action is earnestly solicited.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "J. Leone", is written over a horizontal line.

Joseph T. Leone, Reg. No. 37,170
DEWITT ROSS & STEVENS S.C.
8000 Excelsior Drive, Suite 401
Madison, Wisconsin 53717-1914
Telephone: (608) 831-2100
Facsimile: (608) 831-2106

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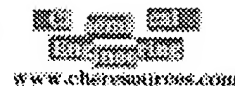
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A Detailed Look at Hydrogen

When most people hear the word "hydrogen" they have flashing images of an exploding blimp. Hydrogen is a fuel that requires energy to retrieve it. In other words, you have to extract hydrogen from another substance....that's the bad news. The good news is that many chemicals (including water) contain hydrogen.

Just the Facts

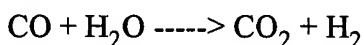
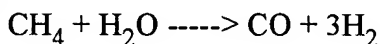
- Energy Content: 1 kg of hydrogen equals 3.5 L of petroleum
- Energy to Volume ratio is 1/4 that of petroleum and 1/3 that of natural gas
- Water consists of 11.2% hydrogen by mass
- Hydrogen burning temperatures can reach 3000 °C in an oxygen atmosphere
- Explosive region for hydrogen is 13%-59%
- Diffusion coefficient for hydrogen is 0.61 cm³/s (4 times that of methane)
- Hydrogen's lower heating value is 120,000 kJ/kg
- Combustion of pure hydrogen yields water as a by-product

Production Methods (Conventional)

Currently, the vast majority of hydrogen is produced from fossil fuel sources as a by-product or reforming.

Steam Reforming of Natural Gas

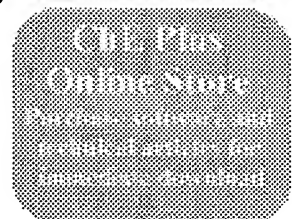
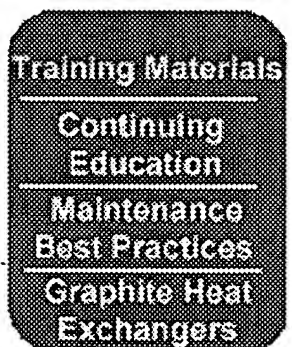
Steam reforming of natural gas is an endothermic, catalytic process carried out at about 850 °C and around 2.5 MPa according to the following reactions:



The carbon monoxide is removed by absorption or membrane separation.

Partial Oxidation of Hydrocarbons

Partial oxidation of hydrocarbons is the exothermic reaction with oxygen and steam. The amounts of oxygen and water vapor are controlled so that the



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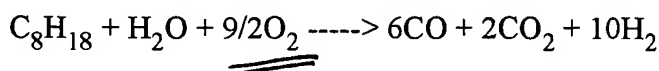
Fuel Cells 2004

The 4th Annual BCC Conference: Fuel Cells on the Move
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reaction proceeds without the need for external energy. An example reaction for this process is:



Plasma Arc Process

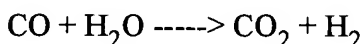
Plasma arc processing of natural gas or oil uses electricity to produce pure carbon and hydrogen at temperatures near 1600 °C. A pilot plant utilizing this technology produced 500 kg/h of carbon and 2000 m³/h of hydrogen from 1000 m³/h of natural gas and 2100 KW of electricity.

Production Methods (Renewables)

Several production methods are used to make hydrogen that utilize a renewable resource as their main fuel source. These renewable resources include biomasses and water.

Steam Gasification of Biomass

Biomass can be used to produce hydrogen via pyrolysis (thermal decomposition) and gasification. The pyrolysis reaction yields coke, methanol, and other gases. With the addition of air the gasification reaction then results in a stream of 20% H₂, 20% CO, 10% CO₂, 5% CH₄, and 45% N₂. This stream can be further processed by reacting it with steam to produce more hydrogen from the carbon monoxide:



Biological Hydrogen Production

Various types of biological hydrogen production methods are in the research stages. Forms of synthetic photosynthesis and fermentation are receiving special attention. One system that seems to be leading the way is an algae-bacteria system that should be ready for the market in around 5 years. A final technology worth noting is the simple electrolysis of water into its component gases, oxygen and hydrogen

FREE RESOURCES